

I Claim:

1 1. Process for ultrahigh temperature pasteurization of a liquid food product using
2 a pasteurization arrangement having a first product-to-product regenerative heat
3 exchanger, a first heater stage, a second product-to-product heat exchanger, and a
4 UHT heater stage; comprising the steps of
5 supplying said liquid food product through a raw-product side of said first
6 regenerative heat exchanger to pre-heat same;
7 heating said preheated liquid food product exiting the first heat exchanger to
8 a predetermined intermediate temperature suitable for denaturizing proteins in the
9 liquid food product;
10 flowing the liquid food product at said intermediate temperature through a
11 timing tube to hold the product at said intermediate temperature for a
12 predetermined time suitable for denaturing said proteins therein;
13 flowing said liquid food product from said timing tube through a raw-
14 product side of said second regenerative heat exchanger to preheat the same from
15 said intermediate temperature to a temperature near a UHT pasteurizing
16 temperature;
17 flowing the liquid food product exiting said second heat exchanger into a
18 medium-to-product heater in said UHT heater stage to heat the liquid food product
19 to a predetermined UHT temperature, the UHT heater stage including means
20 supplying a heating medium in counterflow to said product through said medium
21 to product heater;
22 holding the liquid food product exiting said medium-to-product heater at
23 said UHT temperature for a predetermined length of time;

24 flowing the liquid food product through a pasturized side of said second
25 regenerative heat exchanger in counterflow to the liquid food product flowing in
26 the raw side thereof to transfer heat to the product flowing in the raw side thereof;

27 flowing the liquid food product exiting the pasteurized side of the second
28 regenerative heat exchanger through a pasteurized side of the first regenerative
29 heat exchanger in counterflow to the liquid food product flowing in the raw side
30 thereof to transfer heat to the product flowing in the raw side thereof; and

31 further processing the liquid food product leaving the pasteurized side of the
32 first regenerative heat exchanger to prepare same for packaging;

33 wherein a temperature differential in the medium-to-product heater between
34 the liquid food product and said heating medium at any point of reference in the
35 heater is less than 20 degrees F.

1 2. The process for ultrahigh temperature pasteurization according to Claim 1
2 wherein the liquid food product has a product volume rate of flow through said
3 medium to product heater and said medium has a medium volume rate of flow
4 through said heater, and the ratio of the medium rate of flow to the product rate of
5 flow is below 3:1.

1 3. The process for ultrahigh temperature pasteurization according to Claim 1
2 wherein said ratio of medium to product flow rates is about 2:1.

1 4. The process for ultrahigh temperature pasteurization according to Claim 1
2 wherein the temperature differential in the medium-to-product heater between the

3 product leaving and the medium entering is about 5 degrees F.

1 5. The process for ultrahigh temperature pasteurization according to Claim 1
2 wherein the temperature differential in the medium-to-product heater between the
3 product entering and the medium leaving is about 15 degrees F.

1 6. The process for ultrahigh temperature pasteurization according to Claim 1
2 wherein the temperature differential in the second regenerative heat exchanger
3 between the product leaving the raw side and the product entering the pasteurized
4 side is about less than 20 degrees F.

1 7. The process for ultrahigh temperature pasteurization according to Claim 1
2 wherein said predetermined intermediate temperature is substantially 175 degrees
3 F.

1 8. The process for ultrahigh temperature pasteurization according to Claim 7
2 wherein said predetermined time that said timing tube holds the product at said
3 intermediate temperature is substantially sixty seconds.

1 9. The process for ultrahigh temperature pasteurization according to Claim 1
2 further comprising passing said product through a homogenizer prior to flowing
3 the same through the raw side of the second regenerative heat exchanger.

1 10. The process for ultrahigh temperature pasteurization according to Claim 6

wherein said first and second regenerative heat exchangers are tube-in-tube counterflow heat exchangers.

11. Process for ultrahigh temperature pasteurization of a liquid food product using a pasteurization arrangement having a first product-to-product regenerative heat exchanger, a first heater stage, a second product-to-product heat exchanger, and a UHT heater stage; comprising the steps of

supplying said liquid food product through a raw-product side of said first regenerative heat exchanger to pre-heat same said preheated liquid food product exiting the first heat exchanger to a predetermined intermediate temperature suitable for denaturizing proteins in the liquid food product;

flowing the liquid food product at said intermediate temperature through a device to hold the product at said intermediate temperature for a predetermined time suitable for denaturing said proteins therein;

flowing said liquid food product from said device through a raw-product side of said second regenerative heat exchanger to preheat the same from said intermediate temperature to a temperature near a UHT pasteurizing temperature;

flowing the liquid food product exiting said second heat exchanger into a medium-to-product heater in said UHT heater stage to heat the liquid food product to a predetermined UHT temperature, the UHT heater stage including means supplying a heating medium in counterflow to said product through said medium to product heater;

holding the liquid food product exiting said medium-to-product heater at said UHT temperature for a predetermined length of time;

22 flowing the liquid food product through a pasturized side of said second
23 regenerative heat exchanger in counterflow to the liquid food product flowing in
24 the raw side thereof to transfer heat to the product flowing in the raw side thereof;

25 flowing the liquid food product exiting the pasteurized side of the second
26 regenerative heat exchanger through a pasteurized side of the first regenerative
27 heat exchanger in counterflow to the liquid food product flowing in the raw side
28 thereof to transfer heat to the product flowing in the raw side thereof; and

29 further processing the liquid food product leaving the pasteurized side of the
30 first regenerative heat exchanger to prepare same for packaging;

31 wherein a temperature differential in the medium-to-product heater between
32 the liquid food product and said heating medium at any point of reference in the
33 heater is less than 20 degrees F.

1 12. The process for ultrahigh temperature pasteurization according to Claim 11
2 wherein the liquid food product has a product volume rate of flow through said
3 medium to product heater and said medium has a medium volume rate of flow
4 through said heater, and the ratio of the medium rate of flow to the product rate of
5 flow is below 3:1.

1 13. Process for ultrahigh temperature pasteurization of a liquid food product
2 using a pasteurization arrangement having a product-to-product regenerative heat
3 exchanger and a UHT heater stage; comprising the steps of

4 supplying said liquid food product through a raw-product side of said
5 regenerative heat exchanger to pre-heat same, including denaturizing proteins in

6 the liquid food product, and preheating the liquid food product from said to a
7 temperature near a UHT pasteurizing temperature;

8 flowing the liquid food product exiting said regenerative heat exchanger
9 into a medium-to-product heater in said UHT heater stage to heat the liquid food
10 product to a predetermined UHT temperature, the UHT heater stage including
11 means supplying a heating medium in counterflow to said product through said
12 medium to product heater;

13 holding the liquid food product exiting said medium-to-product heater at
14 said UHT temperature for a predetermined length of time;

15 flowing the liquid food product through a pasturized side of said
16 regenerative heat exchanger in counterflow to the liquid food product flowing in
17 the raw side thereof to transfer heat to the product flowing in the raw side thereof;
18 and

19 further processing the liquid food product leaving the pasteurized side of the
20 regenerative heat exchanger to prepare same for packaging;

21 wherein a temperature differential in the medium-to-product heater between
22 the liquid food product and said heating medium at any point of reference in the
23 heater is less than 20 degrees F.

24 14. The process for ultrahigh temperature pasteurization according to Claim 13
25 wherein the liquid food product has a product volume rate of flow through said
26 medium to product heater and said medium has a medium volume rate of flow
27 through said heater, and the ratio of the medium rate of flow to the product rate of
28 flow is below 3:1.

1 15. The process for ultrahigh temperature pasteurization according to Claim 14
2 wherein said ratio of medium to product flow rates is about 2:1.

1 16. The process for ultrahigh temperature pasteurization according to Claim 13
2 wherein the temperature differential in the medium-to-product heater between the
3 product leaving and the medium entering is about 5 degrees F.

1 17. The process for ultrahigh temperature pasteurization according to Claim 13
2 wherein the temperature differential in the medium-to-product heater between the
3 product entering and the medium leaving is about 15 degrees F.

1 18. The process for ultrahigh temperature pasteurization according to Claim 13
2 wherein the temperature differential in the regenerative heat exchanger between
3 the product leaving the raw side and the product entering the pasteurized side is
4 about less than 20 degrees F.

1 20. The process for ultrahigh temperature pasteurization according to Claim 13
2 wherein the product flowing through said medium-to-product heater has a flow
3 velocity of below about nine feet per second.

1 21. The process for ultrahigh temperature pasteurization according to Claim 20
2 wherein said flow velocity is no greater than about six feet per second.

1 22. In a UHT pasteurizer arrangement comprising a balance tank containing a
2 supply of a liquid food product; a product-to-product regenerative heat exchanger
3 arrangement having a raw product side through which the liquid food product is
4 flowed from the balance tank and a pasteurized side through which pasteurized
5 product is flowed in counterflow relation so that heat is transferred from the
6 pasteurized product to the raw liquid food product to preheat same; a UHT heater
7 stage including a medium-to-product heat exchanger in which the liquid food
8 product leaving the regenerative heat exchanger arrangement enters the medium-
9 to-product heat exchanger where the product is heated to a predetermined UHT
10 temperature, a holding tube in which the liquid food product leaving the medium-
11 to-product heat exchanger is held at said UHT temperature for a predetermined
12 time, and in which the liquid food product leaving the holding tube enters the
13 pasteurized side of the regenerative heat exchanger arrangement; and means
14 further processing the food product leaving the pasteurized side of the
15 regenerative heat exchanger arrangement to prepare same for packaging; the
16 improvement wherein there is a temperature differential in the medium-to-product
17 heat exchanger between the liquid food product and said heating medium, which
18 at any point of reference therein is less than 20 degrees F.

1 23. UHT pasteurizer arrangement according to Claim 22 wherein the flow rate of
2 product through the medium-to-product heat exchanger and the flow rate of
3 medium therethrough are controlled such that the ratio of medium rate of flow to
4 product rate of flow is below 3:1.

1 24. UHT pasteurizer arrangement according to Claim 22 wherein the temperature
2 differential in the medium-to-product heat exchanger between product leaving and
3 medium entering is about 5 degrees F.

1 25. UHT pasteurizer arrangement according to Claim 22 wherein the temperature
2 differential in the medium-to-product heat exchanger between product entering
3 and medium leaving is about 15 degrees F.

1 26. UHT pasteurizer arrangement according to Claim 22 wherein the regenerative
2 heat exchanger arrangement includes first and second stages, and a heater stage
3 situated between said first and second stages, in which liquid food product leaving
4 a raw side of the first stage is heated in a heater to temperature suitable for
5 denaturizing proteins in said liquid food product to prevent the proteins from
6 depositing on walls of the second stage and of the medium-to-product heat
7 exchanger and is held in a timing tube for a predetermined length of time before
8 entering the second stage of the regenerative heat exchanger arrangement.

1 27. UHT pasteurizer arrangement according to Claim 26 wherein said
2 predetermined temperature is substantially 175 degrees F and said predetermined
3 length of time is substantially sixty seconds.

1 28. UHT pasteurizer arrangement according to Claim 22 in which said
2 regenerative heat exchanger arrangement includes at least one tubular heat
3 exchanger in which an inner tube is mounted coaxially within an outer tube to

4 define counterflow paths for said raw side and said pasteurized side.

1 29. UHT pasteurizer arrangement according to Claim 22 in which said medium to
2 product heat exchanger includes a tubular heat exchanger in which an inner tube is
3 mounted coaxially within an outer tube to define counterflow paths for said
4 medium and for said liquid food product.

1 30. UHT pasteurizer arrangement according to Claim 22 in which the regenerative
2 heat exchanger is formed as a three-tube heat exchanger with inner, middle, and
3 outer tubes arranged coaxially.

1 31. UHT pasteurizer arrangement according to Claim 22 in which the medium to
2 product heat exchanger includes a three-tube tubular heat exchanger with inner,
3 middle, and outer tubes that define an inner passage, an outer annular passage, and
4 a middle annular passage, with the product flowing in the middle annular passage
5 and with the medium flowing counter-currently in the inner and outer passages.